

ECE 443/643 Lab 3

October 31, 2011

1 Super Heterodyne Receiver

A superhet is basically just a frequency converter and a filter: it translates a signal up or down in frequency, and rejects noise signals that may be present with the desired signal. At the input is a relatively large bandwidth, low-Q band pass filter, H_{RF} , which rejects the *image response*. Then a mixer shifts the output of H_{RF} with the local oscillator running at f_{LO} . Finally, a small-bandwidth, high-Q band pass filter, H_{IF} , rejects adjacent frequencies and the unwanted mixing products from the local oscillator. For an input signal centered at f_c , f_{LO} is chosen so that $f_{LO} = f_c \pm f_{IF}$, and the particular application dictates which choice is made (in our case, $f_{LO} = f_c + f_{IF}$, for no particular reason). f_{LO} is tunable to select a range of input carriers; it is desirable to keep $\frac{f_{LO, \max}}{f_{LO, \min}}$ as close to 1 as possible. f_{IF} is also dictated by the particular application. The image frequency is $f_{IM} = f_{LO} + f_{IF}$, and is of interest because it gets downconverted to f_{IF} by the mixer, along with f_c , the desired signal. If H_{RF} does not remove the frequency content at f_{IM} , it will interfere with the desired signal at the intermediate frequency stage.

2 Simulation

Matlab is used here to simulate the operation of a super het. Unfortunately, Matlab forces some complications of the simulation because it only deals with finite, discrete arrays of numbers. In this simulation, frequencies are normalized so that the sampling frequency is 1. Also, the filtering gives transient effects due to the finite nature of all of the signals, but I've tried to make them long enough so that the transients are relatively insignificant.

1. Run the Matlab script, with $A_N = 0$ and $A_M = 1$. Comment on how the signal changes in each stage of the super het. You may need to zoom in on the plots, because the signal has a fairly narrow bandwidth.
2. Run the script with $A_N = 1$ and $A_M = 0$. Comment on the signal in each stage of the super het. Pay attention to the y -axis.
3. Run the script with $A_N = 1$ and $A_M = 1$. Is the output signal's spectrum corrupted? What can be modified to fix the corruption? Name at least 2 solutions.